Space Weather Technical Forecast

Issued on Friday, 17 February 2023 at 01:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-flares (R1/R2 Radio Blackouts) likely. G1-G2 Minor/Moderate Storms likely, mainly day 2, due to CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate levels have been observed, with one M-class flare from AR3229 close to the northeast limb, with a further C9.0 flare from the same region later in the period. AR3216, in the northwest quadrant has also produced a C9.0 flare, which was accompanied by a filament eruption. AR3213 and AR3214, which have been active over the last few days, have now both rotated beyond the limb and carry a continuing, but reducing flare risk. AR3226 is the most dominant feature on the visible disc, but has not evolved much in the last 24 hours and still contains a small delta spot. AR3229 is revealing increasing complexity and will continue to be monitored. The remaining four regions are either weak or declining. The filament eruption from the vicinity of AR3216 has been analysed and despite being a rapidly moving feature, is not forecast to be Earth-directed.

Solar Wind / Geomagnetic Activity: Solar wind speeds, observed at L1 increased from 350km/s to average 500km/s as the Earth moved from a CME environment into a high speed stream. The high speed stream is likely to be from a partially obscured coronal hole in the northwest quadrant. Density started above average with a peak of close to 31ppcc at 16/0400UTC, but slowly decreased to an average of between 5ppcc and 15ppc demonstrating the fluctuating nature of the solar wind. There was a small step change at around 16/1600UTC to average below 10ppcc, which may indicate a movement out of the CME influence. Total IMF was initially between moderate and high levels, reaching a peak of 21nT at 16/0806UTC. There was a reduction to mainly moderate levels from 16/1600UTC. The north-south component, Bz varied between strong positive and negative values between 16/0000UTC and 16/1440UTC, with a positive peak of +14nT and a negative peak -20nT. Bz has been weakly to moderately neutral since that time. Phi angle has been predominantly positive (towards the Sun) with only weak and brief negative incursions. Geomagnetic activity was initially Unsettled to Active, with one G1/Minor Storm interval between 16/0600-0900 UTC (Kp 3-5), but became Quiet from 16/1800UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 remained at background levels. High energy electron flux (greater than 2MeV) at GOES16 has been at background levels throughout. The associated 24 hour electron fluence has been below the Active (1e8 integrated pfu) threshold, reaching 2.12e6 integrated pfu at 17/0000 UTC on a steadily increasing trend.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary
Solar Activity: Moderate to Low activity is forecast through the next four days, with sunspots close to the centre disc and on the northeast limb presenting the most significant risk. Further significant sunspots may also rotate onto the visible disc during the period.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on 15 February is due to arrive at Earth around 17/1800UTC, within +/- 12 hours. Otherwise a coronal hole high speed stream is continuing to affect the Earth on 17 February, perhaps easing later in the day. CME influences are likely through 18 February, perhaps easing on 19 February. A further high speed stream is forecast to connect with the Earth on 20 February, with estimated speeds of 500km/s. Quiet to Unsettled geomagnetic activity at first on 17 February, with a low risk of further Active or G1/Minor storms. Active or G1/Minor storm intervals then more likely later on 17 February due to the forecast CME arrival, with this risk continuing, but then decreasing through 18 February. Quiet to Unsettled intervals likely to develop from 19 February, with further lower risk of Active or G1/Minor storms on 20 February.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, but with a slight chance of exceeding S1 in response to any significant flares. High energy (greater than 2 MeV) electron flux may reach high (1e3pfu) levels later in the forecast period, but with low confidence due to a number of modifying factors. The associated 24 hour fluence is expected to remain below the Active threshold (1e8 integrated pfu), but with an increasing chance of rising above later in the period.

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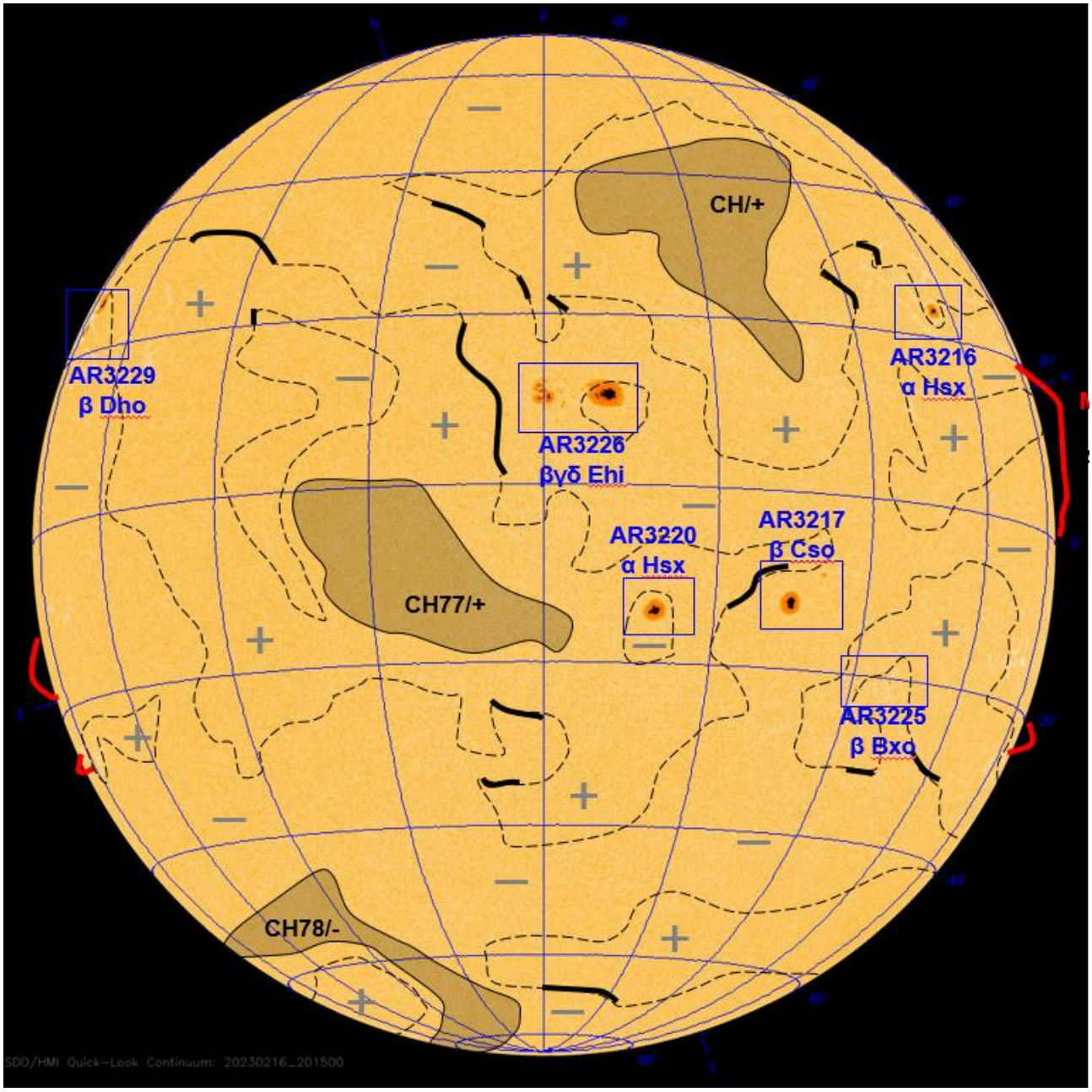
Figure 1. Solar Analysis Valid 16/2000UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME which left the Sun early on 15 February has been analysed and is forecast to arrive late on 17 February, with a potential range of +/- 12 hours. A CME which left the northwest quadrant early on 16 February is forecast to miss the Earth.

The Earth is currently under the influence of a high speed stream from a partially masked coronal hole in the northwest quadrant. Solar wind speeds from this feature are around 500km/s, which is close to speeds forecast by Enlil. A further spike in speed is possible from the CME arrival, with a forecast transit speed of 650km/s from the feature. Speeds may then remain heightened through 18 February and then perhaps declining on 19 February. The high speed stream from coronal hole 77 may then connect with the Earth early on 20 February. Speeds from this feature are estimated to be around 500km/s.

Geomagnetic activity is forecast to start mainly Quiet to Unsettled, but with a chance of Active intervals from any increases in the speed or interplanetary magnetic field. The onset of the anticipated CME may lead to G1/Minor Storm or G2/Moderate Storm intervals. Further G1 Storm periods are possible in 18 February, but with a declining risk. A slight chance of G1/Minor storms from the onset of the coronal hole high speed stream on 20 February.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	60	30	5	10
Strong	G3	No	10	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
15/0815UTC	Partial	Filament	AR3220	650km/s	17/1800UTC +/-12 hours	G1 or G2 storms possible.

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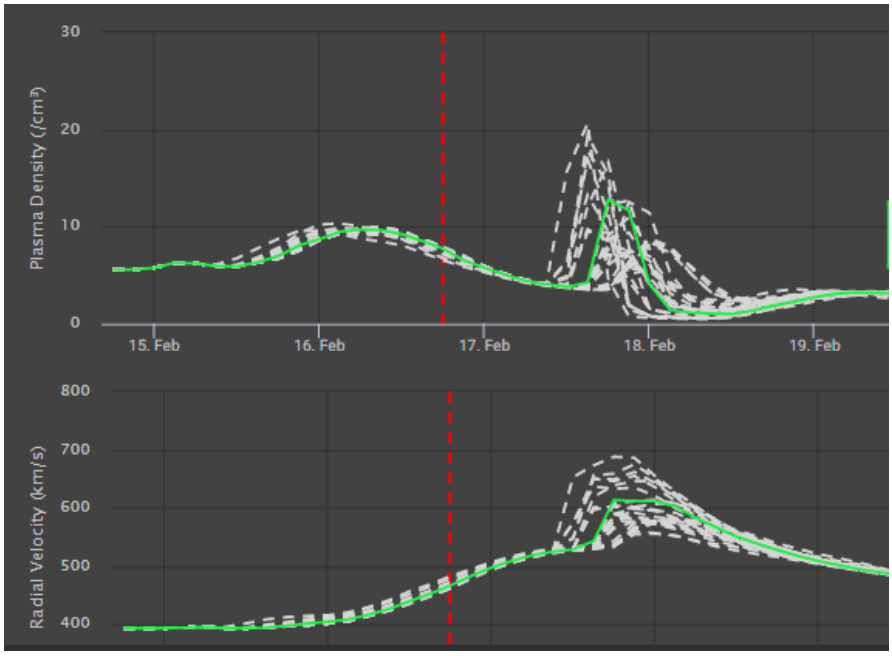
Figure 2: Recent solar wind observations

Figure 3: Enlil ensemble forecast, with the peak around 17 February indicating the range of the possible CME arrival



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Radio Blackouts - X-Ray Flares:

Solar activity is expected to be Moderate to Low, with a risk of M-class flares.

The main risk of flares are from AR3213 and AR3214 which have recently rotated across the northwest limb and have a history of M-class flaring. AR3226, in the north-centre disc has a complex configuration but no recent history of significant flares, but still retains a notable risk. AR3229 on the northeast limb, has already produced M-class flares from beyond the limb, and is revealing increasingly complexity as it rotates further into view. Analysis of farside data suggests that more sunspot regions may rotate onto the visible disc through the forecast period. A risk of M-class flares is therefore maintained through the next four days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels.

Any further significant flares may increase count rates, with a slight chance of exceeding the S1 level. The main risk is from AR3213 and AR3214 which have recently rotated over the northwestern horizon. Any significant flaring from AR3226 also includes the potential to increase count rates as it moves into the western hemisphere.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	10	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) observed at GOES-16 may increase from background levels through the period due to the input from the high speed stream and current CME. However any increase is likely to be modified by the geomagnetic storms from the CME arrival. High levels could then be achieved on 19 February, and then following the onset of the high speed stream on 20 February.

Electron fluence is expected to remain below the Active threshold through 17 February, but with an increasing risk of breaching the Active threshold (1e8 integrated pfu) as the period progresses due to the high speed streams and particle inputs from the CMEs.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	20	20	30	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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